THE ADMISSIBILITY OF NEUROSCIENCE EVIDENCE IN CRIMINAL CASES

BY

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Eduardo Sandoval-Mendoza sold 12 pounds of methamphetamine to his sister's boyfriend, Marcos, and Marcos' friend. Marcos and his friend, it turned out, were paid government informants. Sandoval-Mendoza claimed at trial the informants entrapped him because they knew he had a large brain tumor that made him extremely susceptible to suggestion. Sandoval-Mendoza testified he had talked with Marcos prior to the sales about the possibility the tumor would kill him and about his inability to provide for his family if he died. Marcos suggested Sandoval-Mendoza sell methamphetamine to make money, which he eventually agreed to do. Sandoval-Mendoza sought to introduce *magnetic resonance imaging* (MRI) evidence to support the argument that his tumor affected his judgment and increased the likelihood he would give in to suggestion.[1] Is this evidence admissible at trial or sentencing?

Cases like Sandoval-Mendoza's that rely on evidence concerning the structure or function of the human brain are becoming a daily occurrence in the American criminal justice system. The goal of this article is to provide legal professionals with an effective evidentiary framework for taking advantage of neuroscientific evidence in their practice. Achieving that goal requires a grasp of when a putative neuroscience expert is *qualified*, and an understanding of how to analyze the *relevance* of neuroscience evidence (which combines an inquiry into its *materiality* and the *probative value*), the *helpfulness* of such evidence, and whether its *prejudicial impact* outweighs its relevance.[2] These five concepts will be discussed here, using the Sandoval-Mendoza litigation as an illustrative case.

Expert witnesses proffering neuroscience evidence must be qualified to do so. Expertise in neuroscience requires specialized education, typically received throughout graduate and postdoctoral training. Training may occur in relevant medical specialties, such as neurology, neuroanatomy, and neurophysiology; applied graduate programs in neuroscience and brain and cognitive sciences; and graduate programs in allied fields, such as clinical and experimental psychology. Licensure signifies expert witnesses have reached the threshold in training and experience considered sufficient to practice by their field, while board certification from legitimate organizations denotes individuals with specialized training and experience in a subfield.[3] Continuing education is essential for experts to keep up with the rapid development of practice. In our example, Sandoval-Mendoza attempted to present testimony from a neuropsychologist with expertise in brain damage caused by tumors and from a board-certified neurologist, both of whom were qualified as experts by the court.

Assuming a qualified expert, all evidence proffered must be relevant to the case, which first requires it be material. In other words, there must be a nexus between the proffered evidence and a legal fact at issue in the case. At trial, neuroscience evidence might be material to a

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number of defenses, including the involuntary act defense, diminished capacity, and both the cognitive and volitional prongs of the insanity defense. However, mere evidence of brain damage is of low materiality to any of these defenses, without *additional* evidence the defendant lacked conscious control of his or her actions (required if the involuntary act defense is raised), lacked the mental state required for the crime (required if the diminished capacity defense is raised), or acted irrationally (as required with the cognitive prong of insanity). Even in connection with the volitional prong of the insanity defense, neuroscience evidence linking a brain defect or malfunction will often be of low materiality. For legal purposes, causation (by a brain tumor or any other mechanism) does not amount to compulsion:[4] if it did, all criminal behavior would be compelled, because all behavior is caused by factors over which a person has no control.

The argument in Sandoval-Mendoza's case was Sandoval-Mendoza was entrapped, an argument that focuses on lack of control (similar to the volitional prong of the insanity defense). The defense tried to show he had a brain tumor that affected his brain function in a manner that increased his susceptibility to suggestion from the informants. In contrast, the prosecution expert testified Sandoval-Mendoza had a large pituitary tumor and that, while some brain tumors cause greater susceptibility, the type of tumor Sandoval-Mendoza had was not one of them. The materiality problem in the case is that, even if the defense is right about the nature of Sandoval-Mendoza's tumor, the further assertion that the tumor increased his suggestibility is based, like most scientific assertions, on the study of groups. The law, in contrast, is interested in resolving individual disputes. Translating group-based scientific knowledge into information useful for an individual case can be quite difficult.[5]

One example of this group-to-individual difficulty is the research on frontal lobe dysfunction (FLD), a condition several defendants have claimed decreased their ability to control impulses. One study found individuals who committed violent crimes were 2.5 times more likely to have FLD than nonviolent offenders (73% versus 28%, respectively).[6] On first glance, this finding may seem highly material to the issue of volitional control. But note the research does not indicate the probability that people with FLD will be violent, only the probability that people who are violent have FLD. More material would be research estimating the relative rates of violence among those with and without FLD. One such study estimates the rate for violence among people with FLD is about 10 percent higher than for those without such damage.[7] However, without information about the base rate of violence by people *without* FLD, this research too is of little materiality. If only about 5 percent of the population commits violent crime, for instance, this research would mean only 5.5 percent of people with FLD commit violent crime. That conclusion is not very helpful to defense attorneys who want to suggest FLD leads to uncontrollable outbursts.

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Unfortunately, in many criminal cases the relevant neuroscience research is even less able to speak specifically to the legal question at issue. In Sandoval-Mendoza's case, for example, defense experts testified his tumor damaged his pituitary gland and compressed his frontal lobe, temporal lobe, and thalamus, and that research shows damage to such brain regions can affect decision making and judgment. The prosecution experts pointed out the studies cited by the defense experts were retrospective (as in the first example above), and therefore could not establish a causal relationship. They also provided examples of individuals with similar damage who did not experience deficits in decision making (along the lines of the second example above). The district court excluded the tumor evidence partly because Sandoval-Mendoza failed to establish a causal connection between the tumor and inducement to commit a crime.

To date, most expert testimony about neuroscience has not been proffered at trial (as occurred in Sandoval-Mendoza's case), but at sentencing. In part, this is because evidentiary rules are generally relaxed during this phase.[8] Thus, as an alternative to the entrapment defense, Sandoval-Mendoza could have introduced evidence of his tumor's impact during sentencing in the hopes of receiving mitigation. Even at sentencing, however, neuroscience may not be material. For instance, under federal sentencing guidelines, a downward departure is permissible only if the individual shows "significant impairment" in the ability to control behavior. Only in capital sentencing proceedings is neuroscience evidence of the type Sandoval-Mendoza presented clearly material. In such proceedings, evidence about virtually any mitigating factor must be admitted. At the same time, many states list dangerousness as an aggravating factor. Neuroscience evidence might therefore be material to both the defense *and* the prosecution in such cases.

Even if evidence is legally material, its materiality might be compromised by its lack of "empirical fit." A key aspect of empirical fit is the extent to which neuroscience research can be applied to the criminal justice setting. Many neuroscience studies involve college student participants, small samples, and innocuous stimuli in controlled laboratory settings. This research may not generalize to criminal offenders and offending. Additionally, the manner in which researchers define their variables may not align with the questions being posed to the court, limiting their utility to legal decision making. In Sandoval-Mendoza's case, defense experts agreed there were no studies specifically linking the kind of brain damage he suffered with potential susceptibility to inducement to commit crimes.

The current state of neuroscience research methodology also presents serious problems for empirical fit. Neuroimages are not literal images of brain tissues; rather they represent heuristically derived statistical probabilities, digitally manipulated and modeled relative to a "normal" brain. Neuroimaging studies also present their findings based on group averages, hiding the wide variability often observed within the sample. Although imaging technology and practice will improve, this is likely to remain a significant obstacle to establishing the materiality of neuroscience evidence for the foreseeable future.

The relevance inquiry also requires the court to assess *probative value*—evidence must make a fact at issue in the case either more or less likely. This inquiry requires a showing of what lawyers call *reliability*, and scientists call *validity*. Generally, expert evidence must be based on sufficient facts or data, and be the product of legitimate principles and methods that are accurately applied to the facts of the case.[9]

Probative value can be determined in part by examining whether testing procedures were followed that enhance verifiability, and whether error rates were generated.[10] The measurement of brain structure and functioning can be highly unreliable (in the scientific sense of not being replicable). Structural imaging requires a number of decisions significantly affecting the image of the brain—such as slice thickness, number of slices, and field of view—that vary widely among experts. The quality of neuroimaging studies also varies widely, and poorly designed studies may still be published despite peer review. It is also very difficult to measure neuronal activity via blood flow, which is the bread and butter of functional neuroscience research. Additionally, many brain regions are involved in a wide variety of functions, complicating efforts to connect a particular and unusual brain feature with a particular past behavior. Analyzing these data requires careful statistical work to figure out the probability an actual effect is being observed (statistical significance), and what that effect can meaningfully say about an individual case (effect size). Unfortunately, as many as one-third of studies published in top neuroimaging journals failed to apply appropriate corrections in determining statistical significance,[11] meaning their results may appear significant even when they are not.

If the brain imaging takes place well after the crime, one must also be concerned about whether any damage followed rather than preceded the crime. Although neuroimages of Sandoval-Mendoza's tumor prior to the crime were apparently available, this is often not the case. For instance, it has become common in postconviction capital cases to offer the results of a recent brain scan of someone who has been on death row for years.

In addition to meeting the relevance requirement, evidence must also be *helpful*—it must add to what the triers of fact could figure out themselves. It is a waste of time, money, and patience to introduce

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neuroscience evidence that merely reinforces an argument fact finders would find obvious. Unfortunately the redundant use of neuroscience is likely to increase, given our society's familiarity and fascination with this technology.[12] In contrast, neuroscience is particularly effective when it corroborates an otherwise counterintuitive argument. For example, if neuroscience evidence *can* reliably suggest a tumor impaired the ability to control behavior, it would be helpful to a defendant who intentionally committed an act he knew to be wrong. In this instance neuroscience evidence is not only relevant, it also adds to the fact finders' understanding because it counters their likely preconceptions about such behavior.

The Sandoval-Mendoza case is useful in demonstrating the nuances of the helpfulness inquiry. At Sandoval-Mendoza's trial, the defendant, his ex-wife, and his sister testified he was forgetful and suggestible because of his brain tumor. The defense could argue the neuroscientific testimony corroborated this lay testimony about suggestibility, and therefore was helpful.

Note, however, the prosecution could argue just the opposite: if the jury is given the descriptive lay evidence about Sandoval-Mendoza's heightened suggestibility, then the prosecution might say the neuroscience evidence is redundant and not helpful. Nonetheless, assuming it is sufficiently material and probative, neuroscience evidence tending to show Sandoval-Mendoza's tumor undermined his ability to resist inducements should probably be considered helpful as it corroborates the defendant's otherwise counterintuitive argument that, despite his initial resistance to the informants' inducements, he ultimately succumbed to the informants' encouragement to sell drugs.

The final hurdle to admissibility is the *prejudice* inquiry.[13] Neuroscience evidence may be excluded if its relevance and helpfulness is substantially outweighed by its potential to confuse, distract, or unduly influence the jury. For example, the technicalities of neuroimaging—including the technical decisions made in producing images or measuring functioning, statistical analyses, and bases of empirical and theoretical conclusions described above—might make the eyes of even the most inquiring judge or juror glaze over. The danger of this inattention is that fact finders may give the neuroscience evidence less weight than it is worth.

The opposite concern is the fact finder will pay too much attention to neuroscience evidence and thus be distracted or overinfluenced by it. Early research suggested neuroscience "seduces" and "dazzles" lay and legal decision makers.[14] This work influenced subsequent media portrayals and policy statements about neuroscience, with the use of neuroimages in particular attracting criticism on the ground that pictures of brain can be overly prejudicial. However, various well-conducted studies have since failed to replicate and extend these findings,[15] suggesting this effect was overstated. In the Sandoval-Mendoza case, the trial and appellate courts split on whether the jury could be trusted to weigh such evidence. Although the district court excluded the neuroscience evidence in part because of the likelihood it would confuse the issues or mislead the jury, the Ninth Circuit reversed on the ground that determining how much weight to give to the evidence and whether the tumor caused susceptibility was a question of fact for the jury.

Neuroscience is an impressive scientific and technological tool that will continue to influence decision making in the American legal system. Yet lawyers and courts need to ensure that before it is considered as evidence it is presented by qualified experts, and is material, probative, and helpful, without being unduly prejudicial. An understanding of both neuroscience and its legal admissibility is imperative for legal professionals seeking to use it in criminal litigation.[16] ◆

Endnotes

1. *See generally* United States v. Sandoval-Mendoza, 472 F.3d 645 (9th Cir. 2006).

2. The following analysis is based on the Federal Rules of Evidence (Fed. R. Evid. 104, 401, 403, and 702), but is also relevant in states that have not adopted the Federal Rules of Evidence.

3. For further discussion of board certification in psychology, see Frank M. Dattilio, *Board Certification in Psychology: Is It Really Necessary?*, 33 Prof. Psychol: Res. & Prac. 54, 54–57 (2002).

4. Stephen J. Morse, *Lost in Translation? An Essay on Law and Neuroscience,* in Law and Neuroscience 529, 534 (Michael Freeman ed., 2011).

5. *See generally* David L. Faigman, D. L., John Monahan, & Christopher Slobogin, *Group to Individuals (G2i) Interference in Scientific Expert Testimony,* 81 U. Chi. L. Rev. 417 (2014).

6. Ernest T. Bryant, Monte L. Scott, Christopher D. Tori, & Charles J. Golden, *Neuropsychological Deficits, Learning Disabilities, and Violent Behavior*, 52 J. Consulting & Clinical Psychol. 323, 323–24 (1984).

7. C. Brower & Bruce H. Price, *Neuropsychiatry of Frontal Lobe Dysfunction in Violent and Criminal Behaviour: A Critical Review*, 71 J. Neurology Neurosurgery & Psychiatry 720, 725 (2001).

8. So Yeon Choe, *Misdiagnosing the Impact of Neuroimages in the Courtroom*, 61 UCLA L. Rev. 1502, 1508 (2014).

9. Fed. R. Evid. 702.

10. Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993).

11. *See generally* Craig M. Bennett, George L. Wolford, & Michael B. Miller, *The Principled Control of False Positives in Neuroimaging*, 4 Soc. Cognitive & Affective Neuroscience 417 (2009); Craig M. Bennett, Abigail A. Baird, Michael B. Miller, & George L. Wolford, *Neural Correlates of Interspecies Perspective Taking in the Post-Mortem Atlantic Salmon: An Argument for Multiple Comparisons Correction*, Poster at Human Brain Mapping (2009), *available at* http:// prefrontal.org/files/posters/Bennett-Salmon-2009.pdf.

12. Sally Satel & Scott O. Lilienfeld, Brainwashed: The Seductive Appeal of Mindless Neuroscience xi–xvi (2013).

13. For a larger discussion of the potential prejudicial impact of neuroscience evidence, see Choe, *supra* note 8.

14. For a review, see Adina L. Roskies, N.J. Schweitzer, & Michael J. Saks, *Neuroimages in Court: Less Biasing than Feared,* 17 Trends in Cognitive Science 99, 99–101 (2013).

15. Choe, *supra* note 8 at 1516-27; Adina, Roskies, Schweitzer, & Saks, *supra* note 14, at 99–100.

16. To this end, readers are directed to the *Research Network on Law and Neuroscience (*http://www.lawneuro.org/*),* the *Center for Neuroscience & Society (*http://neuroethics.upenn.edu/*),* and the *Center for Law, Brain, & Behavior (*http://clbb.mgh.harvard.edu/*).*

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